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Soundproof Thermal Shield

The invention relates to a soundproof thermal shield, particularly for motor vehicles, comprising a support made from aluminium, a noise-absorbing layer, and a thermal covering made from aluminium.

Various designs for thermal shields of such kind are known. For example they are used in motor vehicles to prevent heat that radiates from the muffler and other parts of the exhaust system from coming into contact with the car body, and at the same time to provide effective sound insulation. Conventional thermal shields include a supporting aluminium sheet, an inner noise-absorbing layer made of mineral fibres, for example glass fibre, rock fibre, or ceramic fibre, and a closing aluminium foil. Because different materials are used in the noise-absorbing layer and the support layers, disassembling conventional thermal shields into their component materials for recycling is relatively expensive.

A heat and soundproofing material which is made from a single substance to make recycling easier is described in German Patent No. DE 43 29 411 C2 and my be used as a thermal shield in motor vehicle construction. The material consists of multiple aluminium foils, each of which has a corrugated profile of parallel peaks and valleys, gussets being folded into each of the corrugation valleys. The aluminium foils lie freely across each other and are only attached at the edge by means of a tacked seam. While this known material might create an effective thermal shield, its noise-absorbing properties would be less than satisfactory, because the aluminium foils do not have any perforations that are permeable to sound waves.

From German Utility Model DE 91 07 484 U1 a heat shield for shielding of exhaust gas leading parts at an motor vehicle from the underbody of the motor vehicle is known whose face side is constituted by a carrier sheet metal made from aluminium, which carrier sheet metal

carries at its rear side a sound absorbing layer. In order to allow a material sorted disposal of the entire heat shield for recycling purposes, to remain its original layer thickness despite the necessary deformations during the production and to achieve thereby a good insulating effect, the sound absorbing layer is formed of an insert of a regular meshwork made from aluminium and at least one covering foil made from aluminium, wherein the insert is pleated to have a undulation. However, the sound absorbing effect of this heat shield is sometimes not satisfying because it is proposed to implement the pleated insert with at least two layers and to arrange in this case between two layers respectively an aluminium foil as a separating foil.

The task underlying the present invention is to create a soundproof thermal shield of the type described in the introduction, which provides highly effective heat insulation and also has a high noise-absorptivity, and is readily recyclable.

This task is solved according to the invention by the thermal shield having the features cited in claim 1. Advantageous and preferred embodiments of the invention are stated in the subordinate claims.

The thermal shield according to the invention essentially consists of a support made from aluminium, a noise-absorbing layer and a heat shield made from aluminium, the sound-absorbing layer being made from multiple plies of knitted aluminium fabric that are compressed to form a permeable mat.

Since all the elements of the thermal shield according to the invention are made entirely of aluminium, the resulting material being made from a single substance is readily recyclable. The mat-like noise-absorbing layer made from multiple plies of knitted aluminium fabric lends high noise absorbing qualities, particularly of airborne sound, to the thermal shield. The compressed mat corresponds to a porous absorber. The sound waves striking the mat penetrate the narrow pores of the mat and cause the air in the pores to vibrate back and forth, so that the sound energy is converted to heat under the effects of friction. The thermal shield, which is made

from aluminium, provides good thermal insulation, although the perforated aluminium support and the noise absorption layer also enhance the thermal shielding. The thermal shield may consist of an aluminium sheet or preferably an aluminium foil.

Preferably a knitted aluminium fabric in the form of single-thread knitted fabric is used for the noises-absorbing layer. It is relatively easy to vary both the stitch width and the stitch structure of such a knitted aluminium material. By varying the stitch width and stitch structure, it is possible to alter the porosity and/or permeability, and thus also the noise absorption capacity, of the noise absorption layer. In this context, it has proven advantageous if the knitted aluminium fabric is structured such that the average distance between two consecutive stitch wales is larger or smaller than the average distance between the two legs of a stitch. A further advantageous configuration consists particularly in that the knitted aluminium fabric includes stitch wales and/or stitch rows of varying width.

The invention will be explained in greater detail in the following with reference to a drawing representing several embodiments. In the drawing, which is not to scale:

Figure 1 is a cross-section of a thermal shield between a muffler and a car body floor pan;

Figure 2 is a plan view of a section of a mat-type noise absorption layer in a thermal shield according to the invention;

Figure 3 is a schematic representation of a section of a single ply of a knitted aluminium fabric;

Figure 4 is a cross-section of a thermal shield according to a second embodiment between a muffler and a car body floor pan; and

Figure 5 is a cross-section of a thermal shield according to a third embodiment between a muffler and a car body floor pan.

Figure 1 is a schematic representation of a vehicle muffler 1 that emits noise and heat. Muffler 1 is insulated from a floor pan 2 of the vehicle by a trough-shaped or concave thermal shield 3, which also has the effect of insulating airborne noise. Thermal shield 3, which is not drawn to scale has a support 4 made from aluminium, the free side of which is facing the muffler 1. Support 4 consists of a smooth, perforated aluminium sheet having a thickness in the range from 0.5 to 0.8 mm.

It is evident that support 4 has a plurality of apertures 5 to allow noise to pass through. The diameter of these noise pass-through apertures 5 is in the range from 0.1 to 3 mm. A design in which the diameter of the noise pass-through apertures 5 is between 0.1 and 1.9 mm and the support surface has up to 24 noise pass-through apertures 5 per cm^2 is preferred.

A noise-absorbing layer 6 serving particularly to dampen airborne noise is arranged on the inner side of support 4, and is covered by a thermal covering 7 made from aluminium. The thermal covering 7 facing vehicle floor pan 2 consists preferably of an aluminium foil having a thickness in the range from 20 to 80 µm, for example about 50 µm. Thermal covering or aluminium foil 7 may comprise microperforations. The diameter of the microperforation holes (not shown) is in the range from 0.1 to 1 mm, wherein up to 12 holes per cm^2 may be present.

A mesh-type aluminium support may be used instead of thin microperforated aluminium sheet 4, in which case a noise-permeable aluminium foil is preferably arranged between the support and noise absorption layer 6.

The support 4, noise absorption layer 6, and thermal covering 7 of thermal shield 3 are connected to each other by flanging of support 4. The edges of noise absorption layer 6 and of thermal covering 7

are trapped together in flanged border 9. Thermal shield 3 is affixed to the underside of vehicle floor pan 2 preferably by heat and soundproofing fixtures (not shown), for example plastic screws with washers or spacers
made from an elastomer material.

Noise absorption layer 6 is constructed from multiple superimposed plies of a knitted aluminium fabric, in which the plies are compressed to create a mat 10 that is air and gas permeable. Mat 10 is constructed from at least five superimposed plies of knitted aluminium fabric. Mat 10 is an essentially flat formation with relatively high bending strength. A portion of such a mat 10 is shown in Figure 2. The plate-like mat 10 or noise absorption layer 6 has a plurality of small, branched openings or narrow channels 11. In effect, mat 10 thus forms a microporous structure with a plurality of small, open pores. The thickness of noise absorption layer 6 or mat 10 is in the range from 0.5 to 10 mm, preferably in the range from 0.5 to 3 mm. It has a weight per unit area in the range of 8 to 15 g/dm^2. The flow resistance per unit length of mat 10 is equal to or greater than 5 kNs/m^4, preferably equal to or greater than 20 kNs/m^4 in accordance with DIN 52213.

Figure 3 shows a portion of a single ply 12 of the knitted aluminium fabric. It is evident that the knitted aluminium fabric is a single-thread knitted fabric, i.e. that the stitched surface is formed by plaiting a single, transversely running strip-like aluminium thread 13. Each stitch consists of a head 14, two legs 15, 16 and two feet 17, 18. The adjacent stitches form a correspondingly transverse stitch row, while several superimposed stitches form a so-called stitch wale.

The knitted aluminium fabric is constructed such that the average distance a between two consecutive stitch wales is significantly greater than the average distance b between the two legs 15, 16 of a stitch. In the embodiment shown, the average distance a between two consecutive stitch wales is about twice as large as the average distance b between the two legs 15, 16 of a stitch.

The embodiment shown schematically in Figure 4, which is also not drawn to scale, differs from the embodiment shown in Figure 1 in that support 4 and thermal covering 7 are profiled. Both support 4 and thermal covering 7 have a zig-zag profile, which is created for example by corresponding compression forming. The zig-zag profiles of support 4 and thermal covering 7 form gusset-shaped cavities 19 in the upper and lower sides of noise absorption layer 6, which particularly have a heat insulating effect.

Support 4 is also provided with a plurality of noise pass-through apertures 5. When viewed from the direction of the muffler 1, the apertures 5 are each disposed at the bottom of the gusset valleys. Noise pass-through apertures may also be disposed on the outer gusset peaks of support 4 besides or instead of this arrangement.

A third embodiment is shown in Figure 5, in which thermal shield 3 again comprises an aluminium support 4 with a smooth surface, a noise absorption layer 6 and a thermal covering 7 made from aluminium foil. This embodiment differs from the embodiment shown in Figure 1 primarily in that a spacer 20 is arranged between perforated support 4 and noise absorption layer 6. Spacer 20 consists of a profiled aluminium foil, which is preferably perforated. Aluminium foil 20 is constructed in a corrugated, zig-zag, or other such profiled manner, with the result that a slit-shaped air gap 21 is created, particularly with thermal insulating effect, between support 4 and noise absorption layer 6.

The embodiment according to Figure 5 further differs from the embodiment shown in Figure 1 in that thermal shield 3 has an additional noise absorption layer 6', wherein a spacer 20' is also arranged between the two noise absorption layers 6, 6'. Spacer 20' may be constructed like the spacer 20. It serves to create a heat insulating air gap and may consist particularly of a profiled and perforated aluminium foil. A correspondingly profiled spacer 20'' is also provided between noise absorption layer 6' and thermal covering 7.

As in both of the previous embodiments, noise absorption layers 6, 6' are each made from several plies of a knitted aluminium fabric that have been compressed to form permeable mat. Noise absorption layers 6, 6' thus have the form of flat compressed mats.

The performance of the invention is not limited to the embodiments described above. On the contrary, a range of variants are possible that are also based on the inventive idea defined in the attached claims, while differing fundamentally in construction. For example, the thermal shield 3 according to the invention may be used not only for covering a muffler 1 or other parts of a motor vehicle exhaust system, but also for example for shielding areas of the engine block from the dashboard of the passenger compartment. In particular, it is within the scope of the present invention to combine individual features of the embodiments described above.